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Diagnostic Prevalence of Diabetes Among Older Adults in Rural Appalachia

CAPSTONE PROJECT PAPER

A paper submitted in partial fulfillment of the requirements for the degree of
Master of Public Health in the University of Kentucky College of Public Health

By

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Lexington, Kentucky

April 17, 2017

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Abstract

Background

The rural, mountainous Appalachian region continuously has poorer health outcomes than the rest of the United States. This is true for many chronic diseases including diabetes: the 7th leading cause of death in the United States. This study assessed differences in the prevalence of diagnosed diabetes between older adults in rural, Appalachian counties and rural, non-Appalachian counties.

Methods

Data for the year 2013 was extracted from the Centers for Medicare and Medicaid Services (CMS) Public Use Files for Medicare beneficiaries (September 2015), which provides county level prevalence for diabetes as well as several other conditions among Medicare fee-for-service beneficiaries. Appalachian counties were defined as those considered Appalachian by the Appalachian Regional Commission. Rural and non-rural counties were defined using the 2013 Economic Research Service Rural-Urban Continuum codes (RUCCs). Differences in the prevalence of diagnosed diabetes were assessed using a negative binomial regression.

Results

In the final model, diagnostic diabetes prevalence was slightly lower in the rural, Appalachian group when compared to non-rural reference group (PR: 0.98 [95% CI: 0.97-1.00]). While in the rural, non-Appalachian group, diagnostic prevalence was slightly higher when compared to the reference group (1.01 [95% CI: 0.99-1.02]). Although, the difference was not statistically significant for either group.

Conclusion

Because of earlier onset of diabetes in Appalachia, it is possible that diagnostic prevalence of diabetes begins to level off in an older adult population. Another possible explanation for no statistically significant difference in prevalence being found between these groups is that low access to care in rural, Appalachia results in more undiagnosed and untreated cases. Further studies using individual level data and looking at all age groups would be needed to better understand diabetes prevalence in rural, Appalachia.

Introduction

Rural and Appalachian Disparities

Multiple studies support the idea that rural areas are generally worse off when it comes to health than urban areas.¹⁻⁴ It appears to be true for all ages and all races: rural populations are less healthy than urban populations.⁴ People in rural areas tend to have higher prevalence of obesity, higher rates of chronic disease, and they tend to die younger.^{1,5,6} Appalachia, which is approximately 80% rural, seems to be disproportionately affected.¹ Appalachian states hold the top spot for highest rates of heart disease, stroke, diabetes, lung cancer, and a host of other conditions. Central Appalachian states such as West Virginia, Kentucky, and Tennessee tend to dominate the top ten lists in rates of chronic disease. They repeatedly have had higher rates than states in North Appalachia: New York, Pennsylvania, Maryland, and Ohio. These rural, Central Appalachian states also have higher rates of chronic disease than many states in the west that are also largely rural such as Wyoming, Nebraska, and Idaho.^{5,6}

The geography of the Appalachian region is thought to be one of the primary reasons for the area's poor health outcomes in relation to the rest of the country. The mountainous terrain of the

area makes it difficult to access.^{1,3} There are fewer interstates and highways connecting rural Appalachia to the surrounding areas.¹ There are instead smaller winding roads that must be taken to get to and from these various mountain towns. Not only does this seclusion stunt economic growth, but it can also deter residents from leaving the area to get medical care. These areas often have primary care physicians but may not have specialists or a major-medical center nearby. This may result in patients failing to attend follow up appointments with specialists when recommended by a general practitioner, or it could mean the difference between life and death when trying to reach a hospital during an emergency situation.

This physical isolation also creates food deserts. United States Department of Agriculture (USDA) looks at the percentage of residents within a census tract that have low access to supermarkets (considered more than a mile from supermarkets for urban areas, and more than 10 miles from a supermarket for rural areas), low access to vehicles, and low income to determine if an area is a food desert. Many Appalachian counties, particularly in central Appalachia, have a significant portion of their population meeting those conditions and are considered food deserts.⁷ Living in a food desert often results in a diet lacking fresh, healthy foods, which leads to higher rates to obesity. The high rates of obesity contribute to higher rates of chronic disease as we see in most Appalachian states.^{5,6,7}

Diabetes Mellitus

Diabetes is one of the many chronic diseases through which the health disparities in Appalachia can be seen. In 2013 and 2014, seven out of the top ten states for diabetes prevalence were Appalachian States.^{5,6} Diabetes Mellitus is the 7th leading cause of death in the United States and is a risk factor for a host of other chronic diseases including heart disease and stroke—the leading cause and fifth leading cause of death in the United States, respectively.⁶ The Centers for

Disease Control and Prevention (CDC) estimates that 29.1 million Americans have diabetes, and that 8.1 million (27.8%) of those cases are undiagnosed.⁵

Diabetes mellitus is a chronic metabolic disease defined by high fasting blood glucose levels.

There are two major types of diabetes. In both types insulin, a hormone produced by the pancreas plays a key role. Insulin is produced and secreted by beta cells found in the islets of Langerhan—clumps of specialized cells in the pancreas. The function of insulin is to facilitate uptake of glucose from the bloodstream into various types of tissue throughout the body—muscle, brain, liver, fat—where the glucose can then be converted into energy.⁸

Type I diabetes is caused by an autoimmune response that destroys the insulin producing beta cells. This type is primarily diagnosed in children and adolescents, and it makes up only a small portion of total diabetes cases. Type II is much more common, making up 90-95% of all cases of diabetes. It is caused by insulin resistance: muscle, fat, and liver cells not responding properly to insulin making it difficult for glucose from the bloodstream to be absorbed for energy production and storage. Higher levels of insulin are needed in the bloodstream to help glucose be absorbed. Beta cells in the pancreas produce more insulin to meet the demand. This helps the body maintain normal blood glucose levels. Over time, beta cells may reach a point where they are no longer meeting the level of insulin required to maintain normal glucose levels; this is when type II diabetes occurs. Insulin resistance develops over time—often over many years. Because of this, type II diabetes is more common among elderly populations.^{8,9}

Blood glucose tests are used to diagnose diabetes. Fasting plasma glucose test, oral glucose tolerance test, random blood test (used primarily as a screening tool), and hemoglobin A1c are examples of tests used in diagnosing diabetes. Most of these tests show only the blood glucose level at the time of testing. The exception is the hemoglobin A1c, which assesses average

glucose levels over a period of 2-3 months. The test works by measuring the percentage of hemoglobin bound to glucose within the 120-day life cycle of a red blood cell.^{8,9} Regardless of which tests is used, a repeat confirmatory test, using the same type of test, is required for diagnosis.⁸

Once diagnosed, treatment may vary depending upon the type of diabetes and the severity of the disease. Treatment of type I diabetes always requires insulin. Type II diabetes may require the use of insulin, but other measures can be taken to manage it. Metformin is an oral medication used to treat type II diabetes. Type II diabetes also can often be controlled by adopting a modified diet, increasing physical activity, and losing weight.^{8,9}

While the etiology of either type of diabetes is not entirely understood, there are several known risk factors for type II diabetes. Obesity, poor diet, inactivity, old age, and family history are some of these risk factors.^{8,9} Because old age is a risk factor, we expect to see higher rates of diabetes in those over 65. Nationally, the over 65 population makes up 13.1% of the U.S. population.¹⁰ In many rural areas, the percentage of over 65 residents is higher. With such a large portion of Appalachia being rural, it is not surprising that diabetes prevalence rates are higher in those areas: as of the 2010 census, residents over the age of 65 made up 15.0 percent of Appalachia's population.¹⁰

As mentioned above, Appalachian states also tend to have higher rates of obesity; over a third of the population in several Appalachian states including West Virginia, Kentucky, Alabama, Mississippi, and Tennessee is obese.⁶

I hypothesized that even in states with high diabetes prevalence, diagnosed diabetes among older adults would be higher in rural, Appalachian counties than in either urban or rural, non-

Appalachian counties. This hypothesis was tested using data from the Centers for Medicare and Medicaid Services (CMS) Public Use Files for Medicare beneficiaries to conduct an ecologic study.

Methods

Study Population

The sample was taken from the September 2015 CMS public use data file which provides county level prevalence for diabetes as well as several other conditions among Medicare fee-for-service beneficiaries (beneficiaries that are enrolled in Medicare Part A and B and chose the fee-for-service option); this does not include Medicare Advantage beneficiaries.¹¹ The World Health Organization's Ninth Revision, International Classification of Diseases (ICD-9) codes relating to the diagnosis or treatment of diabetes were used to determine diagnosis of diabetes for beneficiaries. While the dataset covers multiple years, this study only assessed data from 2013.

Only states with counties in central or south central Appalachia were analyzed in this study due to rates of many chronic diseases and negative health behaviors being higher in these states than in other parts of Appalachia.¹² Central and south central Appalachian counties were defined using the sub-regions developed by Appalachian Regional Commission (ARC). All Appalachian counties in four of the five states in the analysis—Kentucky, North Carolina, Tennessee, and Virginia—fell completely within central and south central Appalachia. The fifth state, West Virginia, is entirely Appalachian and contains counties in the central, north central and northern sub-regions. Data for all counties in these five states were extracted from the original CMS dataset in order to analyze differences in diabetes prevalence between rural, Appalachian; rural, non-Appalachian; and non-rural counties in this region. Rural counties were categorized using

the 2013 Economic Research Service Rural-Urban Continuum codes (RUCCs). Counties with an urban population of less than 20,000 were considered rural (RUCC codes 6-9). All other counties (RUCC codes 1-5) were considered non-rural.

Statistical Analysis

This is an ecologic study examining differences in diabetes prevalence between rural, Appalachian and rural, Non-Appalachian counties. County level data from the CMS dataset described above, was used to calculate prevalence rates of diagnosed diabetes based on a negative binomial regression. Negative binomial regression was chosen because count data was being used—count of beneficiaries diagnosed with diabetes was the dependent variable in this analysis. Poisson regression would have required the mean and variance to be the same, and thus the model would have been too inflexible. The offset used in this regression was the log of the number of fee for service beneficiaries. The regression as well as all other calculations were performed in SAS 9.4.

Two models were constructed to estimate adjusted prevalence ratios. To account for potential confounders, several variables that are known to be risk factors for type II diabetes were included in the original model. All control variables were measured at the county level and included: hypertension, high cholesterol, beneficiary average age, ischemic heart disease, and stroke. Chronic kidney disease, percent male, and Medicaid eligibility were also included. There were two major reasons for including chronic kidney disease. The first is that end stage renal failure is one way that an individual can become eligible for Medicare before age 65. The second reason is that diabetes is the number one cause of chronic kidney disease, so counties with high rates of chronic kidney disease should also have high rates of diabetes.

The first model (Model 1) included all of the covariates listed above that could have potentially been confounders. In the second model (model 2), backwards elimination was applied to identify the most parsimonious model.

Results

There was a total of 3,950,817 fee for service Medicare beneficiaries in 501 counties and county equivalents across 5 states. Of these beneficiaries, 3,085,382 were in non-rural areas, 450,206 were in rural Appalachian counties, and 415,229 were in rural non-Appalachian counties. There were 263 counties in the reference group, 108 counties in the rural Appalachian group, and 130 in the rural non-Appalachian group.

The rural, Appalachian group had a slightly larger male population compared to the rural, Non-Appalachian and reference groups. The rural, Appalachian group (68.4) was, on average, younger than both the rural, non-Appalachian group (70.4) and the reference group (70.2) (Table 1). In addition to being younger on average, the ages in the rural, Appalachian group were more widely distributed with average age ranging from 62-74. For rural, non-Appalachian counties the range for average age was 66-74, and for the urban group it was 65-76. The overall younger Medicare population and wider distribution of age in rural, Appalachia is likely due to Appalachia having a larger proportion of their population on disability when compared to the rest of the country.^{11,12} Those on disability for 24 months or longer would have been eligible for Medicare regardless of their age.

The percentage of fee for service beneficiaries with diabetes was higher in rural non-Appalachian counties (30.0%) than in rural Appalachian counties (29.1%), although both were higher than the non-rural reference group (28.1%) (Table 1). Similarly, prevalence rates were

highest in the rural non-Appalachian group for hypertension, chronic kidney disease, high cholesterol, and stroke (Table 1). Ischemic heart disease was the only chronic condition in the analysis for which rural, Appalachia had the higher prevalence.

Unadjusted prevalence ratios were higher for the rural, non-Appalachian group (1.08) than the rural, Appalachian group (1.06). The prevalence ratios were also higher in the rural, non-Appalachian group for both models (Table 2). However, the relationship between diagnosed diabetes among Medicare beneficiaries was not statistically significant for either group. Prevalence of diagnosed diabetes was statistically significantly associated with higher rates of chronic kidney disease. This would be expected knowing that diabetes is the leading cause of ESRD.¹⁷

Discussion

Previous studies looking at prevalence of diabetes in Appalachia have found higher rates in Appalachia compared to Non-Appalachian counties within their own states (Schwartz). Similarly, they found that Appalachian counties had higher rates of other chronic conditions such as heart disease and certain cancers.^{5, 6, 14, 15}

One study comparing rates of hypertension in Appalachian vs non-Appalachian counties in Kentucky found no significant difference in rates of hypertension between Appalachian and non-Appalachian counties.¹⁶ This study was one of only a few instances I found in the literature that found prevalence of a chronic condition to be lower in the Appalachian group. This was similar to the results of the current analysis where prevalence for all diagnosed conditions, with the exception of ischemic heart disease, was slightly higher in the rural, non-Appalachian group compared to the rural, Appalachian group.

This analysis only looked at diagnosed diabetes. The isolation of the Appalachian region limits access to care so it is possible that beneficiaries in those counties are less likely to visit a physician to get a diagnosis and be treated.^{1,3} If this is the case, it would explain the lower prevalence rates despite most of the literature supporting the hypothesis that rural, Appalachia has higher prevalence of diabetes and other chronic conditions.

Many of the examples from the literature that found higher rates of diabetes in rural, Appalachia used the Behavioral Risk Factor Surveillance System (BRFSS) data where survey participants have self-reported their disease status.^{13,14,15} In contrast, the CMS data used for this study bases diagnoses on ICD-9 codes. BRFSS results are also meant to be representative of the entire population. By looking at prevalence in a Medicare population it is only representative of fee for service Medicare beneficiaries, which are largely over the age 65. Those which are not over the age of 65 would have qualified due to having end stage renal disease (ESRD) or receiving disability benefits for at least two years. We would expect diabetes as well as many of the other chronic diseases included in this analysis to have higher prevalence in a Medicare population when compared to the general population due to the age and health conditions, which make someone eligible. For diabetes, the prevalence in a Medicare population is likely affected by Medicare beneficiaries that qualified by having ESRD as diabetes is the leading cause.¹⁷

A 2011 paper by Barker found the age of diabetes diagnosis to be younger in Appalachian counties.¹³ It stratified Appalachia into ARC development categories. Residents of counties in the lowest ARC category, distressed, were diagnosed on average 2.8 years younger than those in non-Appalachian counties.¹³ Counties in the distressed category are of particular interest because most of the distressed categories are found in central and south central Appalachia.

The unadjusted average ages at diagnosis in the same study ranged from 50.0-52.0 across the development categories. This is far younger than the average age of any group in this study using a Medicare population. Additionally, type II diabetes diagnoses are being seen in younger patients—even in adolescence. It is possible that by age 65 when most people enroll in Medicare, the difference in prevalence between rural, Appalachian; rural, non-Appalachian, and urban groups has begun to level off. Having prevalence rates among all ages would be a better representation of the population as a whole. This may also be part of why other studies did find higher rates of diabetes and other chronic conditions in Appalachia.

Limitations

This study only assessed diabetes prevalence of Medicare beneficiaries among states in central Appalachian during one year. One limitation of using this population in an entirely ecological analysis is that any relationships seen in these results cannot be determined to causal because it is unknown if a beneficiary lived in their current county for their entire life or moved there later in life—possibly even after developing diabetes. Additionally, a causal relationship could not be proven because the data is county level rather than individual level.

This analysis and most of the existing literature looking at health disparities within Appalachia compare Appalachian counties to other counties within their own states. It is possible that Non-Appalachian counties within these states share the same poor health outcomes as their Appalachian counterparts. The diabetes belt, identified by CDC, supports this idea.¹⁸ With the exception of the Nashville area, every county in Tennessee is included in the diabetes belt while only the Eastern half of the state is considered Appalachian. Similarly, all of Mississippi and nearly all of Alabama are in the diabetes belt while only the northern portion of those states are Appalachian. Further studies comparing diabetes prevalence between rural Appalachia and rural

counties in states outside of the diabetes belt—potentially states in the Western United States—could improve the understanding of high diabetes prevalence and other health disparities in Appalachia.

Assessing only Medicare beneficiaries limits the conclusions that can be drawn from this analysis. The Medicare population consists primarily of those over the age of 65. This was appropriate for testing the hypothesis of this particular study, but other studies have indicated that the average age for diabetes diagnosis is younger than 65 and that average age at diagnosis is younger in Appalachia than in other parts of the country.¹³ To better understand disparities in diabetes prevalence among all residents of rural, Appalachia, further studies using a data set that is representative of the population as a whole would be needed.

Another potential limitation to the approach taken in this study, is grouping several levels of rurality together: The rural-urban continuum has 9 levels. While this study grouped them into one rural group and one non-rural group. This ignores differences between levels. For example, a non-metro area with a population of greater than 20,000 was considered non-rural, but so was a metro area with 2 million or more residents.

Conclusion

Taking into consideration the younger diagnosis rates of diabetes in Appalachia, it is possible that the disparity in diagnostic prevalence may level off in the older adult population. Many of those diagnosed younger may have already died. Earlier death, in addition to beneficiaries qualifying for Medicare in alternate ways, helps explain the younger average age in rural, Appalachian counties. Further studies looking at diabetes among all age groups would be needed to determine if this is the reason for diagnostic prevalence appearing to level out in older adults.

CDC estimates 8.1 million Americans living with diabetes are undiagnosed cases. It may be that a disproportionate number of those cases are residents of rural, Appalachia. Low access to care in Appalachia is likely leading to fewer beneficiaries in these counties being diagnosed with and receiving treatment for their diabetes. This would result in lower diagnostic prevalence of diabetes in rural, Appalachia while true prevalence in the area may actually be higher than that in rural, non-Appalachian, and non-rural counties. Additional studies would be required to determine if this is actually the case.

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Appendix I

Table 1: Central Appalachia Medicare Beneficiary Characteristics by Residence: Rural, Appalachian; Rural, Non-Appalachian; and Non-rural, Non-Appalachian.

Beneficiaries Characteristics	All Beneficiaries	Rural, Appalachian	Rural, Non-Appalachian	Non-rural (Reference)
Average Age (in Years)	69.8 ±2.0	68.4 ±2.4	70.4±1.3	70.2 ±1.7
% Male	46.3	48.7	45.3	45.4
Eligible for Medicaid (%)	24.4	31.7	24.5	20.7
Diabetes (%)	28.8	29.1	30.0	28.1
Hypertension (%)	58.9	58.6	61.0	58.1
Ischemic Heart Disease (%)	27.8	29.6	28.3	26.8
Chronic Kidney Disease (%)	15.9	14.7	16.7	16.2
High Cholesterol (%)	46.2	45.5	45.8	46.7
Stroke (%)	3.5	3.2	3.7	3.6

Table 2: Prevalence of Diagnosed Diabetes with 95% Confidence Intervals* Among States in Central and South Central Appalachia.[†]

Variables	Unadjusted	Model 1	Model 2
Rural Appalachian	1.06 (1.00-1.13)	0.99 (0.97-1.01)	0.98 (0.97-1.00)
Rural Non-Appalachian	1.08 (1.02-1.13)	1.01 (0.99-1.03)	1.01(0.99-1.02)
Average Age, 1 year	-	0.98 (0.98-0.99)	0.99 (0.98-0.99)
Male	-	1.00 (0.99-1.00)	-
Eligible for Medicaid	-	1.02 (1.01-1.03)**	1.02 (1.01-1.03)**
Hypertension	-	1.13 (1.10-1.16)**	1.15 (1.13-1.16)**
Chronic Kidney Disease	-	1.09 (1.06-1.12)**	1.09 (1.06-1.12)**
Stroke	-	1.07 (0.97-1.19)**	-
High Cholesterol	-	1.01 (0.99-1.03)**	-
Heart Disease	-	0.99(0.97-1.01)**	-

*results based on negative binomial regression **comparison is a 10% change [†]Analysis included Kentucky, North Carolina, Tennessee, Virginia, and West Virginia

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BIOGRAPHICAL SKETCH

Gabriella Hodges attended the University of the Cumberlands in Williamsburg, Kentucky where she majored in Biology and minored in Chemistry. She earned a Bachelor of Science degree in May of 2013. In August 2014, she continued her education at the University of Kentucky College of Public Health where she pursued a Master of Public Health with a concentration in epidemiology. During her time at the University of Kentucky she worked as a graduate research assistant in the Kentucky Healthcare Associated Infection Prevention Program. Since February 2016, she has been working as the regional epidemiologist in the Cumberland Valley Region of Kentucky.